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HAMPTON ROADS TRANSIT

Draft Environmental Impact Statement VIRGINIA BEACH TRANSIT EXTENSION STUDY

Appendix H *Conceptual Cost Estimates for the Build Alternatives*

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1.0 Introduction

The purpose of this report is to document the conceptual-level capital cost estimates for the bus rapid transit (BRT) and light rail transit (LRT) build alternatives under consideration in the Virginia Beach Transit Extension Study (VBTES). The cost estimates are based on conceptual engineering design plans dated August 27, 2014, which can be found in Appendix G of the VBTES Draft Environmental Impact Statement (DEIS).

The estimates in this report and supporting documents are based on the methodology outlined in the Capital Cost Methodology Report dated April 2010 and the Association for the Advancement of Cost Engineering International Recommended Practice No. 17R-97 (Cost Estimate Classification System) Class 4, 0 to 15% Project Definition. The estimate has an accuracy range index of 4, which is equal to a +40% to -20% range of accuracy.

Unit costs for these estimates have been estimated for the third quarter of 2013 and have been escalated to the year of expenditure as described in **Section 3**, assuming the start of revenue service in 2020 for all alternatives. The estimates reflect the total project cost including right-of-way acquisition, site preparation, guideway, vehicles, maintenance facilities, soft costs, and contingencies.

2.0 Description of Project Build Alternatives

This section summarizes the four alternatives for the Virginia Beach Transit Extension Study that are presented in this report. All of the build alternatives under consideration would provide fixed guideway transit service to extend The Tide east between Newtown Road and the Virginia Beach Oceanfront Resort Area.

2.1 Light Rail Transit Alternatives

There are four alignment alternatives under consideration for the VBTES: Newtown Road to Town Center, Newtown Road to Rosemont, Newtown Road to the Oceanfront Station via the former Norfolk Southern Railway right of way (NSRR ROW), and Newtown Road to the Oceanfront Station via Laskin Road. A summary of physical characteristics of the alternatives is in **Table 1**. Conceptual engineering drawings for each of the LRT alternatives are in Appendix G of the VBTES DEIS.

2.1.1 Alternative 1A: Newtown Road Station to the Proposed Town Center Station (Town Center Alternative)

Alternative 1A would follow the former NSRR ROW from The Tide's Newtown Road Station to a station at the Town Center of Virginia Beach (See **Figure 1**). The length of this alternative is approximately 3.0 miles; its exact distance depends on the selected location for the end of line station at Town Center.

Beginning at the Newtown Road Station, this alternative would travel east along the former NSRR ROW as a double track ballasted section. The alignment would cross Newtown Road and Princess Anne Road at-grade.

Continuing east, the alignment would cross Greenwich Road at-grade and pass under the existing I-264 bridge before rising to be grade separated over Witchduck Road. A station with a Park & Ride and bus transfer area would be located east of Witchduck Road, along Southern Boulevard. The alignment would cross Euclid Road and Kellam Road at-grade. In the Town Center area east of Kellam Road, the alignment would depend on the location that is selected for the station. One of the following four station location options will be selected:

- ~ At-grade, immediately west of Independence Boulevard with a pedestrian bridge over Independence to a park and ride on the east side of the road; or,
- ~ On a new transit bridge over Independence Boulevard and Market Street with the boarding platforms directly over Independence Boulevard; or,
- ~ On a new transit bridge over Independence Boulevard and Market Street with the boarding platforms directly over Market Street; or,
- ~ At-grade, immediately west of Constitution Drive (a new transit bridge would be required over Independence Boulevard and Market Street for this station site option).

Construction of Alternative 1A would not require a new vehicle storage and maintenance facility (VSMF). The existing facility for The Tide in Norfolk would continue to be used for the entire line with modifications to accommodate the additional vehicles and equipment for the Operations Control Center.

Figure 1 | Alternative 1A Alignment



Source: HDR, Inc. August 2014

2.1.2 Alternative 1B: Newtown Road Station to the Proposed Rosemont Station (Rosemont Alternative)

Alternative 1B would follow the former NSRR ROW from The Tide's Newtown Road Station to the proposed Rosemont Station located east of Lynn Shores Drive (See **Figure 2**). The length of this alternative is approximately 4.8 miles.

From the Newtown Road Station to the Town Center area, Alternative 1B would be the same as Alternative 1A. The Town Center Station would be at one of three locations: on a new transit bridge over Independence Boulevard, on a new transit bridge over Market Street, or at-grade west of Constitution Drive. The alignment would cross Constitution Drive at-grade and continue east.

East of Constitution Drive, the alignment would cross Thalia Creek on a new structure. The alignment would then cross Fir Avenue, Thalia Road, and Budding Avenue at-grade. The alignment would continue at-grade across South Kentucky Avenue and Lynn Shores Drive before entering the Rosemont Station. The alignment would end approximately 400 feet east of the station for space for vehicle storage.

Construction of Alternative 1B would not require a new VSMF. The existing facility for The Tide in Norfolk would continue to be used, with modifications proposed to accommodate the additional vehicles and equipment for the Operations Control Center.

Figure 2 | Alternative 1B Alignment



Source: HDR, Inc. August 2014

2.1.3 Alternative 2: Newtown Road Station to the Proposed Oceanfront Station via NSRR ROW (NSRR Alternative)

Alternative 2 would follow the former NSRR ROW from The Tide's Newtown Road Station to the Virginia Beach Oceanfront Resort Area (see **Figure 3**). The total length of this alternative is approximately 12.2 miles.

From Newtown Road to the Rosemont Station, this alignment is the same as Alternative 1B. Extending east from the Rosemont Station, the alignment would rise to be grade-separated over Rosemont Road and cross South Plaza Trail at-grade. Past South Plaza Trail, the alignment would cross North Lynnhaven Road at-grade before coming to a station with a Park & Ride lot along Southern Boulevard between North Lynnhaven Road and Lynnhaven Parkway.

East of the Lynnhaven Station, the alignment would rise to be grade separated over Lynnhaven Parkway. The alignment would then cross London Bridge Creek on a new bridge and go under I-264 using an existing overpass. After passing under I-264, the alignment would rise to be grade separated over London Bridge Road. Continuing east from London Bridge Road, the alignment would continue along the former NSRR ROW north of NAS Oceana. There would be a North Oceana station with a Park

& Ride lot on City-owned property west of Air Station Drive. Continuing east from the new station, the alignment would remain at-grade and cross Air Station Drive, South First Colonial Road, Oceana Boulevard, Sykes Avenue and Distribution Drive before reaching the east end of the former NSRR ROW at Birdneck Road.

At Birdneck Road, the alignment would turn north and then east at Virginia Beach Boulevard. The double track section in this area would generally consist of retained ballast on concrete ties along Birdneck Road and Virginia Beach Boulevard, then it changes to embedded track before turning onto Washington Avenue. At Washington Avenue, the alignment turns north to pass through the parking lot at the Virginia Beach Convention Center. The Convention Center Station would be located immediately south of 19th Street. At 19th Street, the alignment turns east to the end-of-line Oceanfront Station at 19th and Arctic Avenue. The tracks would be coordinated with the City's streetscape improvement project on 19th Street.

A new VSMF would be located on property owned by the City of Virginia Beach north of Potters Road, adjacent to the North Oceana Station and Park & Ride.

Figure 3 | Alternative 2 Alignment



Source: HDR, Inc. August 2014

2.1.4 Alternative 3: Newtown Road Station to the Proposed Oceanfront Station via Laskin Road (Hilltop Alternative)

Alternative 3 would follow the former NSRR ROW from The Tide's Newtown Road Station to London Bridge Creek, then it would split from the right of way to go through the Hilltop area, using Laskin Road and Birdneck Road to reach the Virginia Beach Oceanfront Resort Area (see **Figure 4**). The length of this alternative is approximately 13.5 miles.

From Newtown Road to London Bridge Creek, this alignment is the same as Alternative 2. East of London Bridge Creek, between the creek and I-264, the alignment would leave the NSRR ROW onto its own alignment parallel to I-264. The alignment turns northeast on a bridge that would cross over Virginia Beach Boulevard and Great Neck Road. The alignment would continue on a bridge north of the Virginia Beach Boulevard/Laskin Road interchange, and then it would cross over the westbound lanes of Laskin Road. The alignment would continue south of the westbound lanes on a structure over

the I-264 onramp before touching down in the median of Laskin Road west of Phillip Avenue, where the eastbound and westbound lanes of Laskin Road converge.

The alignment would continue at-grade in the median of Laskin Road in a retained ballast double track section. A new walk-up station would be located between Republic Road and the Hilltop Plaza Shopping Center entrance. The alignment would cross over the First Colonial Road intersection on a bridge that begins east of Hilltop Plaza Shopping Center and touches down again in the median of Laskin Road near Nevan Road. It would continue in the median of Laskin Road with another station located near the Hilltop East Shopping Center entrance. A Park & Ride lot would be located at the southeast corner of Laskin Road and Winwood Drive.

The alignment would continue east in the median of Laskin Road, crossing over Linkhorn Bay on a new combined transit/roadway bridge, until it intersects with Birdneck Road. At Birdneck Road, the alignment turns south into the median, and the track section changes from ballasted to embedded. A new station would be located in the median of Birdneck Road south of Laskin Road, and a Park & Ride lot would be located at the southeast corner of the Laskin Road and Birdneck Road intersection. The alignment would continue in the median of Birdneck Road, passing under I-264, until it reaches 19th Street.

At 19th Street, the alignment would move from Birdneck Road into the center lanes of 19th Street, which would be exclusive for LRT use. East of Jefferson Avenue would be the Convention Center station. Existing parking lots would be used to serve this station, and no additional parking would be constructed. The alignment would continue in the center of 19th Street; east of Parks Avenue, Alternative 3 would be the same as Alternative 2, in the center of 19th Street to the end of line Oceanfront station west of Arctic Avenue.

The VSMF for Alternative 3 would be on the City's Potters Road site, at the same location proposed under Alternative 2. For LRT vehicles to reach this site, a non-revenue track would be constructed along the former NSRR ROW between London Bridge Creek and the VSMF. The crossing of London Bridge Road would take place at-grade, and non-revenue vehicles would proceed through the intersection with a traffic signal without preemption.

Figure 4 | Alternative 3 Alignment



Source: HDR, Inc. August 2014

Table 1 | Summary of LRT Alternative Characteristics

	Alternative 1A	Alternative 1B	Alternative 2	Alternative 3
Stations				
At grade	2 (3 ^a)	3 (4 ^a)	7 (8 ^a)	9 (10 ^a)
Aerial	1 (0 ^a)	1 (0 ^a)	1 (0 ^a)	2 (1 ^a)
Access to Stations				
New Park & Ride Lot	2	3	5	7
Walk-up	0	0	1	2
Alignment				
Length (miles)	3.0 (approx.)	4.8	12.2	13.5
Grade separations	2 (1 ^b)	2	5	6
Water crossings	0	1	2	3
Facilities				
VSMF	Existing Tide facility (with modifications)	Existing Tide facility (with modifications)	Potters Road (new)	Potters Road (new)
Vehicles				
Light Rail Vehicle	4	5	10	10
Feeder Bus	12	10	11	11

Source: HDR, Inc. August 2014

^a Number in parentheses indicates number of stations with Town Center West (Alternative 1A only) or Constitution (Alternatives 1A, 1B, 2, or 3) station options at Town Center.

^b Number in parentheses indicates number of grade separations with Town Center West station option.

2.2 Bus Rapid Transit Alternatives

The VBTES includes a BRT mode option corresponding to each of the LRT alternatives. This section describes these alternatives. Characteristics of the BRT alternatives are summarized in **Table 2**.

2.2.1 Alternative 1A: Newtown Road Station to the Proposed Town Center Station (Town Center Alternative)

Alternative 1A for BRT would follow the same alignment along the former NSRR ROW as the LRT Alternative 1A described in **Section 2.1.1**. A grade separation would occur at Witchduck Road. A grade separation over Independence Boulevard and Market Street would be constructed for any of the station locations that are over or east of Independence Boulevard. The station locations and Park &

Ride lot sites identified for the LRT alternative would be the same for the BRT. Because HRT does not have available space at their existing facilities to maintain the articulated buses that would be used for the BRT system, a new VSMF would need to be constructed for this alternative. For conceptual design purposes, the BRT VSMF is assumed to be at the Potters Road site owned by the City of Virginia Beach under all alternatives.

2.2.2 Alternative 1B: Newtown Road Station to the Proposed Rosemont Station (Rosemont Alternative)

Alternative 1B for BRT would follow the same alignment along the former NSRR ROW as the LRT Alternative 1B described in **Section 2.1.2**. Grade separations would occur at Witchduck Road and Independence Boulevard. Station locations and Park & Ride lot sites identified for the LRT alternative would be the same for the BRT. As with Alternative 1A, a new BRT VSMF would need to be constructed for this alternative.

2.2.3 Alternative 2: Newtown Road Station to the Proposed Oceanfront Station via NSRR ROW (NSRR Alternative)

The BRT Alternative 2 would follow the former NSRR ROW described for the LRT Alternative 2, with the same station locations and grade-separated intersections. At the east end of the former NSRR ROW, the BRT vehicles would turn onto Birdneck Road and begin operating in mixed traffic on local streets to reach the stations at the Virginia Beach Convention Center and Oceanfront Resort Area.

A new VSMF for BRT would be located in the same location identified for the LRT facility, on City of Virginia Beach property north of Potters Road, adjacent to the North Oceana Station and Park & Ride.

2.2.4 Alternative 3: Newtown Road Station to the Proposed Oceanfront Station via Laskin Road (Hilltop Alternative)

The BRT Alternative 3 would construct a new exclusive busway following the former NSRR ROW from Newtown Road to London Bridge Creek, similar to that described for LRT Alternative 3. Station locations and grade-separated intersections would be in the same locations as the LRT alternative.

East of London Bridge Creek, the BRT guideway would turn north to connect to Parker Lane. At Parker Lane, BRT vehicles would begin to operate in mixed traffic along Virginia Beach Boulevard and through the interchange with Laskin Road and I-264, serving a station in the Great Neck area. BRT vehicles would transition to an exclusive guideway on Laskin Road east of Phillip Avenue. The guideway would continue in the median of Laskin Road east to Birdneck Road, with a grade-separated crossing over First Colonial Road. Station locations and Park & Ride lots on Laskin Road would be in the same locations as the LRT Alternative 3. At Birdneck Road, the exclusive BRT guideway ends. BRT vehicles would operate in mixed traffic on Birdneck Road and 19th Street to serve stations in the Birdneck area, Virginia Beach Convention Center, and Oceanfront Resort Area.

A new VSMF for BRT would be located in the same location identified for the LRT facility, on the City of Virginia Beach property north of Potters Road. Buses would access the VSMF using existing roadways.

Table 2 | Summary of BRT Alternative Characteristics

	Alternative 1A	Alternative 1B	Alternative 2	Alternative 3
Stations				
At grade	2 (3 ^a)	3	7	9
Aerial	1 (0 ^a)	1	1	1
Access to Stations				
New Park & Ride Lot	2	3	6	7
Walk-up	0	0	1	2
Alignment				
Length (miles)	3.0 (approx.)	4.8	12.2	13.5
Grade separations	2 (1 ^b)	2	5	5
Water crossings	0	1	2	3
Facilities				
VSMF	Potters Road (new)	Potters Road (new)	Potters Road (new)	Potters Road (new)
Vehicles				
BRT Vehicle	7	7	11	12
Feeder Bus	12	10	11	11

Source: HDR, Inc. August 2014

^a Number in parentheses indicates number of stations with Town Center West (Alternative 1A only) station option at Town Center. For BRT Alternatives 1B, 2, and 3, only the aerial station over Independence Boulevard was considered.

^b Number in parentheses indicates number of grade separations with Town Center West station option.

3.0 Cost Estimating Methodology

This section describes the methodology for developing the VBTES conceptual cost estimates, including key assumptions, sources of information, and other inputs.

3.1 Assumptions

3.1.1 Design Sources

For each of the LRT and BRT alternatives under consideration, conceptual engineering designs have been developed. Typical sections for the project were created, and their limits were identified as appropriate along the alignments under consideration in the VBTES.

These designs are at a 5% to 10% level, which is sufficient for the purpose of supporting the DEIS. While the degree of design development varies by discipline, most project elements have not been completely developed. Therefore, the conceptual estimates represent an order of magnitude cost. As the design is refined during future phases of the project, the accuracy of cost estimates will improve.

Existing Conditions Data

Data representing existing conditions comes from the following sources:

- ALTA survey collected for the purchase of the NSRR ROW,
- Geographic Information System (GIS) level information obtained from the City of Virginia Beach and utility operators,
- information obtained from VDOT's Laskin Road Phase II project,
- topographic surveys taken specifically for the VBTES project in the Great Neck area and along Birdneck Road and 19th Street west of Parks Avenue,
- topographic survey taken of 19th Street east of Parks Avenue as part of the City's proposed streetscape project,
- aerial photography from the City of Virginia Beach supplemented with aerials taken of the areas covered in the surveys of the Great Neck area and along Birdneck Road and 19th Street.

Existing topography for developing vertical alignments is from a surface model that was created using LIDAR data provided by the City of Virginia Beach.

Utility Information

Existing utility information is shown on the ALTA survey, other surveys, and in GIS files. This information has not been field verified. Surveys of the Great Neck and Birdneck Road areas did not include subsurface utilities. The locations of major public and private utility facilities were discussed in general terms during stakeholder meetings that have occurred periodically throughout the course of the VBTES, but specific design or disposition of these utilities have not been identified in the conceptual design.

Dominion Virginia Power has provided paper copies of their records showing locations of transmission and distribution lines along the former NSRR ROW.

Real Estate

Real estate boundaries and estimated appraised values are based on information provided by the City of Virginia Beach. Boundaries of the NSRR ROW and adjacent properties were located by the ALTA survey and have been incorporated into the design. Right of way limits and property lines in the areas of the supplemental survey have also been incorporated into the design.

3.1.2 Cost Data Sources

Cost information was compiled by HDR. Unit and lump sum costs for items identified in the conceptual design were obtained from recent transit projects and historical data using Timberline estimating software and supplemented by unit costs from construction of The Tide. They are based on the complete in-place costs of construction, including labor, materials, equipment, supplies, overhead, and profit. Unit costs were adjusted to the 2013 base year. During a series of workshops with HRT and City of Virginia Beach staff in 2013, the unit and lump sum costs were adjusted to reflect actual experience during construction of The Tide and recent construction bids.

Utility costs for City of Virginia Beach water and sanitary sewer facilities are based on the average cost per linear foot of The Tide for construction contracts 30 and 40 (which incorporated most of the civil and utility work for the project). The bid value was escalated to the base year, and then it was doubled to account for discrepancies between the bid and actual costs that were experienced during construction.

Real estate costs are based on City of Virginia Beach assessments for the year 2013. The assessed values of parcels that were identified as complete acquisitions were increased to represent the additional cost of relocations. Costs for partial acquisitions were proportional to the amount of the property that would be taken for the project, assuming that the value of the parcel is homogenous; for example, an acquisition of 10% of a parcel would cost 10% of its assessed value regardless of which portion of the property is being taken. Fees and other legal costs to transfer properties owned by the City of Virginia Beach for project-related use were based on a discounted percentage of the assessed value for each parcel.

The cost of the former NSRR ROW was allocated proportionally according to the percentage of the right of way that would be used for each alternative, since the Town Center, Rosemont, and Hilltop alternatives would not operate along the entire length of the property that was purchased. Under the FTA cost estimating methodology, costs related to the purchase of the former NSRR ROW and other properties that would potentially be used as part of the local match to federal funding are included as part of the project-related cost.

Add-on items such as professional services costs and design contingencies are based on a percentage of the base cost. Professional services costs are discussed in **Section 3.2.1**, design contingencies are in **Section 3.2.2**. Escalation to year of expenditure is discussed in **Section 3.2.3**.

3.2 Standard Cost Categories

The Federal Transit Administration (FTA) established a standard format for reporting and estimating capital projects under the New Starts program, which allows for easier comparison of costs between projects. There are ten Standard Cost Categories (SCC), which are listed in **Table 3**. Most categories have line items for project elements that costs can be assigned to. Each SCC and line item has been defined by FTA to identify which elements belong in each category.

Table 3 | FTA Standard Cost Categories

SCC Category Number	Description
10	Guideway and Track Elements
20	Stations, Stops, Terminals, Intermodal
30	Support Facilities: Yards, Shops, Admin. Buildings
40	Sitework and Special Conditions
50	Systems
60	Right of Way, Land, Existing Improvements
70	Vehicles
80	Professional Services
90	Unallocated Contingency
100	Finance Charges

Source: Federal Transit Administration

For development of the VBTES cost estimates, construction-related elements in SCC categories 10 through 50 were identified from the conceptual design (where possible) and entered into spreadsheets. Unit costs were assigned, and then those items were grouped by SCC category so that the subtotals could be transferred to the appropriate section of the SCC worksheets. Costs for real estate (SCC category 60) and vehicles (SCC category 70) were determined separately and entered into the SCC worksheets.

3.2.1 Summary of Elements in Standard Cost Categories

The SCC worksheet provided by FTA contains definitions of each category and line item as well as examples of elements that are to be included. Appendix H-2 of this report lists the items that were identified from the conceptual design for each alternative, their unit costs, and additional detail regarding what is included with each item and assumptions that were made.

Category 10: Guideway and Track Elements

This category includes costs for rough grading, excavation, and site preparation of the transit guideway (LRT tracks or BRT roadway). Separate line items are provided for exclusive guideway, semi-exclusive, guideways in mixed traffic, aerial structures, built-up fill, and retained fill. Costs for LRT tracks are assigned to Category 10, with items for ballasted, embedded, and direct fixation track. Costs for the BRT roadway pavement are covered under Category 40. Special trackwork and track treatments for noise and vibration attenuation are identified in this category.

Category 20: Stations, Stops, Terminals, Intermodal

Costs for stations are entered under this category. There are separate items for at-grade and aerial stations, parking garages, and elevators.

Category 30: Support Facilities: Yards, Shops, Administration Buildings

This category covers costs for administration buildings, vehicle maintenance facilities (separated into light maintenance and heavy maintenance functions), and maintenance of way buildings. All costs of those buildings are included, such as site preparation, materials, building construction, building components (HVAC, electrical, plumbing, life safety), and equipment for performing the building's functions. Yards and yard tracks are a separate item under this category.

Category 40: Sitework and Special Conditions

Project-wide clearing, demolition, and grading are a part of Category 40. Utility work and relocations, civil elements such as roadways and sidewalks, miscellaneous site structures, and parking lots (including park and ride facilities at stations) are covered under this category. All paving for the BRT roadway is in this category, but site preparation for the guideway is in Category 10. Costs for environmental mitigation and hazardous materials removal are considered in this category.

Category 50: Systems

The systems category includes train control systems, train signals and crossing protection (signals and gates at grade crossings, for example), traction power systems, communication systems, fare collection equipment, and central control facilities. Traffic signals outside of the guideway and for BRT operations are covered under this category.

Category 60: Right of Way, Land, Existing Improvements

This category includes costs for real estate that will be used for the project, including acquisitions, permanent easements, and temporary easements. It includes real estate that would be used as part of a local match for Federal funding of the project. For the VBTES conceptual estimates, this includes the costs of the former NSRR ROW and properties currently owned by the City of Virginia Beach that have been identified as potential Park & Ride sites for the Witchduck and Town Center stations. Legal

fees, professional services, and administrative costs for the real estate component of the project are a part of this category.

For the VBTES, real estate costs were determined as described in **Section 3.1.2**. A separate item in Category 60 is designated for relocation costs, but these have not been specifically identified in the VBTES at this time.

Category 70: Vehicles

Costs for vehicles are identified in Category 70. Separate line items are provided for each type of vehicle; for the VBTES, only light rail and buses are used, but there are items available for non-revenue vehicles, spare parts, and other types of rail vehicles. Costs for professional services associated with vehicle procurement are included.

Category 80: Professional Services

Professional services costs were automatically calculated in the SCC worksheets based on a percentage of the construction subtotal. These percentages are listed in **Table 4**.

Table 4 | Professional Services Costs as a Percentage of Construction Cost

SCC Line Item Number	Description	Percentage of Total Construction Cost
80.01	Project Development	2.50%
80.02	Engineering	12%
80.03	Project Management for Design and Construction	5%
80.04	Construction Administration and Management	8%
80.05	Professional Liability and other Non-Construction Insurance	2%
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	2%
80.07	Surveys, Testing, Investigation, Inspection	2%
80.08	Start up	1.50%

Source: HDR, Inc.

Category 90: Unallocated Contingency

The unallocated contingency is added on to the subtotal of Categories 10 through 80. It represents financial reserves for the project that are not associated with any particular scope item. For the VBTES conceptual estimates, unallocated contingency was applied at 2% of the total for SCC categories 10 through 80.

Design contingencies allocated to individual scope items are discussed in **Section 3.2.2**.

Category 100: Finance Charges

Finance charges associated with the project are entered in this category. They are to be based on the project's financial plan. A financial plan has not been created for this phase of the VBTES.

3.2.2 Design Contingency

In order to account for uncertainty in unit costs, future changes in quantities, and project elements that have not been defined in the conceptual design, contingency factors were applied to the estimate. For individual items in the SCC worksheet, a contingency factor was applied which was variable due to differences in the level of development of the conceptual design and identification of cost-related risks associated with each item. The item-specific contingency, known as allocated contingency, was applied as a percentage of the base year cost. **Table 5** shows the levels of allocated contingency used for each item for the VBTES conceptual cost estimates. The contingency percentages will be reduced in cost estimates that are based on advanced levels of design.

An additional level of contingency, known as unallocated contingency, was applied to the estimate at 2% of the total for SCC categories 10 through 80. This amount represents financial reserves for the project that are not associated with any particular scope item.

Table 5 | Levels of Allocated Contingency by SCC Category

SCC Category	Description	Allocated Contingency Percentage
10	GUIDEWAY & TRACK ELEMENTS	
10.01	Guideway: At-grade exclusive right-of-way	35%
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	35%
10.03	Guideway: At-grade in mixed traffic	35%
10.04	Guideway: Aerial structure	35%
10.05	Guideway: Built-up fill	35%
10.06	Guideway: Underground cut & cover	35%
10.07	Guideway: Underground tunnel	35%
10.08	Guideway: Retained cut or fill	35%
10.09	Track: Direct fixation	30%
10.10	Track: Embedded	30%
10.11	Track: Ballasted	30%
10.12	Track: Special (switches, turnouts)	30%
10.13	Track: Vibration and noise dampening	30%
20	STATIONS, STOPS, TERMINALS, INTERMODAL	
20.01	At-grade station, stop, shelter, mall, terminal, platform	30%

20.02	Aerial station, stop, shelter, mall, terminal, platform	30%
20.03	Underground station, stop, shelter, mall, terminal, platform	30%
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.	30%
20.05	Joint development	30%
20.06	Automobile parking multi-story structure	35%
20.07	Elevators, escalators	35%
30	SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	
30.01	Administration Building: Office, sales, storage, revenue counting	30%
30.02	Light Maintenance Facility	30%
30.03	Heavy Maintenance Facility	30%
30.04	Storage or Maintenance of Way Building	30%
30.05	Yard and Yard Track	30%
40	SITEWORK & SPECIAL CONDITIONS	
40.01	Demolition, Clearing, Earthwork	35%
40.02	Site Utilities, Utility Relocation	40%
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments	40%
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks	40%
40.05	Site structures including retaining walls, sound walls	35%
40.06	Pedestrian / bike access and accommodation, landscaping	35%
40.07	Automobile, bus, van accessways including roads, parking lots	35%
40.08	Temporary Facilities and other indirect costs during construction	35%
50	SYSTEMS	
50.01	Train control and signals	35%
50.02	Traffic signals and crossing protection	35%
50.03	Traction power supply: substations	35%
50.04	Traction power distribution: catenary and third rail	35%
50.05	Communications	35%
50.06	Fare collection system and equipment	35%
50.07	Central Control	35%
60	ROW, LAND, EXISTING IMPROVEMENTS	
60.01	Purchase or lease of real estate	Lump Sum
60.02	Relocation of existing households and businesses	Included in 60.01
70	VEHICLES	
70.01	Light Rail	20%
70.02	Heavy Rail	N/A
70.03	Commuter Rail	N/A

70.04	Bus	20%
70.05	Other	N/A
70.06	Non-revenue vehicles	N/A
70.07	Spare parts	N/A
80	PROFESSIONAL SERVICES	
80.01	Project Development	12%
80.02	Engineering	5%
80.03	Project Management for Design and Construction	8%
80.04	Construction Administration & Management	2%
80.05	Professional Liability and other Non-Construction Insurance	2%
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	2%
80.07	Surveys, Testing, Investigation, Inspection	2%
80.08	Start up	3%

Source: HDR, Inc. 2013

3.2.3 Escalation

Unit costs that were used to develop the conceptual cost estimates were based on values from the third quarter of 2013 (the base year). To account for inflation, costs plus allocated contingencies for the base year were escalated to the projected year of expenditure (YOE). The YOE total represents the cost of the project at the time that costs are expected to be incurred.

To determine the rate of escalation, three cost indices were consulted: the IHS Global Insight Highway and Street Index, the Engineering News Record Construction Cost Index, and the IHS PPI Finished Consumer Goods Index. For each year between 2013 (the base year) and 2020 (the opening year), the highest of the three index values was taken for calculating the escalation rate used in the VBTES conceptual cost estimates. **Table 6** shows the index values between 2013 and 2020 along with the rate for each year that was used in the estimates.

Table 6 | Construction Cost Indices for VBTES

Year	IHS Global Insight Highway and Street Index	ENR Construction Cost Index	IHS PPI Finished Consumer Goods Index	VBTES Rate	VBTES Cost Index
2013	Base				1.0000
2014	1.4	4.7	0.1	4.7	1.0470
2015	2.5	3.4	0.8	3.4	1.0826
2016	2.9	2.2	1.8	2.9	1.1140
2017	2.5	2.4	1.0	2.5	1.1418
2018	2.2	2.4	1.1	2.4	1.1692
2019	2.0	2.7	1.6	2.7	1.2008
2020	2.0	2.6	2.0	2.6	1.2320

The assumed years of expenditure are listed in **Table 7**.

Table 7 | Assumed Year of Expenditure

SCC Category	Description	Year of Expenditure
10-50	Construction items: Guideway and track, Stations, Support Facilities, Sitework and Special Conditions, Systems	2018 ^a
60	Real estate currently owned by the City of Virginia Beach	2013
60	Real estate not currently owned by the City of Virginia Beach	2017
70	Vehicles	2019
80	Professional Services: Project Development	2016
80	Professional Services: Engineering	2017
80	Professional Services: Construction-related activities (project management, administration, insurance, legal, surveys and inspections)	2018 ^a
80	Start-up activities	2020
90	Unallocated contingency	2018 ^a

Source: HDR, Inc. August 2014

^a 2018 is the assumed midpoint of construction year.

4.0 Summary of Conceptual Cost Estimates

4.1 Light Rail Transit Alternatives

Capital cost estimates were developed for the four LRT alternatives. **Table 8** shows a summary of the base year (2013) and year of expenditure costs for the LRT Alternatives and Town Center station options. Additional details for each estimate can be found in the SCC worksheets in Appendix H-1 of this report.

FTA's SCC definitions state that costs of land for the project are included under Category 60 if that value is to be used as part of the local match for federal funding. The methodology for developing the conceptual costs for the VBTES has assumed that the costs of real estate that have already been expended (for the former NSRR ROW and sites for the Witchduck and Town Center station park and ride lots that are currently owned by the City of Virginia Beach) would be used as part of a local match if federal funding were to be pursued; therefore, these costs are included in the Category 60 total. The SCC worksheets do not provide separate line items to differentiate real estate that is currently owned by the City of Virginia Beach from real estate that would be acquired in the future for this project. The costs in **Table 8** include the totals as shown on the SCC worksheets for each alternative, the cost of expended real estate, and the cost of the remaining project elements through construction and opening.

At the Town Center of Virginia Beach, four station options are under consideration: west of Independence Boulevard (applicable to Alternative 1A only), over Independence Boulevard, over Market Street, and west of Constitution Drive. The Independence and Market Street options would be aerial stations, while the platforms for Town Center West and Constitution Drive would be at-grade. Because the station types and structure lengths are different among the options, separate cost estimates for each station option were developed for LRT Alternatives 1A, 1B, and 2 to determine if changing the station location had a significant effect on the cost. The range of base year costs for Alternative 1A was \$264.5 million for the Town Center West option to \$307.2 million for the Constitution Drive option. This large difference can be attributed to the structure over Independence Boulevard that would be required to build a station at Constitution but not for the location west of Independence. For Alternatives 1B and 2, it was found that the difference between the highest cost (Market Street) and lowest cost (Constitution Drive) station option was approximately \$3.5 million in the base year; in these alternatives, a full length bridge over Independence Boulevard and Market Street would be built regardless of where the Town Center Station is located. The conceptual cost estimate for Alternative 3 was developed with only the Independence station option. The Market Street station location option in Alternative 2 was approximately \$4.3 million more than the Independence option, and the Constitution option in Alternative 2 was approximately \$3.8 million less than Independence. These differences are assumed to be valid for Alternative 3 as well, since the conceptual designs are the same for Alternatives 2 and 3 in this area.

The total costs for Alternative 3 include as part of the transit project the reconstruction of the Laskin Road roadway within the limits of the current VDOT project (Republic Road to Birdneck Road) using

the six-lane section identified in the conceptual design. A separate SCC worksheet has been prepared to account for that roadway reconstruction.

Table 8 | Summary of LRT Alternative Conceptual Cost Estimate Totals

LRT Alternative	Base Year Dollars (x1000)			YOE Dollars (x1000)		
	Without expended real estate	Expended real estate cost	Total (SCC)	Without expended real estate	Expended real estate cost	Total (SCC)
Alternative 1A (Town Center West)	\$236,744	\$27,715	\$264,459	\$276,325	\$30,503	\$306,828
Alternative 1A (Independence)	\$275,620	\$27,715	\$303,335	\$321,676	\$30,503	\$352,179
Alternative 1A (Market)	\$274,814	\$27,715	\$302,529	\$320,735	\$30,503	\$351,238
Alternative 1A (Constitution)	\$279,515	\$27,715	\$307,230	\$326,219	\$30,503	\$356,722
Alternative 1B (Independence)	\$373,957	\$34,508	\$408,465	\$436,192	\$37,295	\$473,487
Alternative 1B (Market)	\$377,600	\$34,508	\$412,108	\$440,443	\$37,295	\$477,738
Alternative 1B (Constitution)	\$370,418	\$34,508	\$404,926	\$432,065	\$37,295	\$469,360
Alternative 2 (Independence)	\$827,679	\$58,146	\$885,825	\$966,348	\$61,231	\$1,027,579
Alternative 2 (Market)	\$831,323	\$58,146	\$889,469	\$970,598	\$61,231	\$1,031,829
Alternative 2 (Constitution)	\$824,431	\$58,146	\$882,577	\$962,558	\$61,231	\$1,023,789
Alternative 3*	\$1,076,905	\$55,428	\$1,132,333	\$1,254,575	\$59,270	\$1,313,845

Source: HDR, Inc. August 2014

*Conceptual cost estimate for Alternative 3 is based on the Independence station option.

4.2 Bus Rapid Transit Alternatives

Cost estimates were developed for the three BRT alternatives in a similar manner as the LRT alternatives, except that BRT Alternatives 1B, 2, and 3 only considered the Independence station option at Town Center. BRT Alternative 1A considered the Independence station option and the location west of Independence Boulevard. A summary of these estimates is in **Table 9** with separate columns for expended real estate similar to the method described for the LRT alternatives. The SCC worksheets in Appendix H-1 provide additional information for the estimates in FTA's Standard Cost Categories format.

Table 9 | Summary of BRT Alternative Conceptual Cost Estimates

BRT Alternative	Base Year Dollars (x1000)			YOE Dollars (x1000)		
	Without expended real estate	Expended real estate cost	Total (SCC)	Without expended real estate	Expended real estate cost	Total (SCC)
Alternative 1A (Town Center West)	\$227,395	\$27,714	\$255,109	\$263,906	\$30,500	\$294,406
Alternative 1A (Independence)	\$270,377	\$27,714	\$298,091	\$314,046	\$30,500	\$344,546
Alternative 1B	\$329,398	\$34,506	\$363,904	\$384,189	\$37,293	\$421,482
Alternative 2	\$593,793	\$56,471	\$650,264	\$692,578	\$59,271	\$751,849
Alternative 3	\$721,362	\$45,140	\$766,502	\$838,500	\$48,111	\$886,611

Source: HDR, Inc. August 2014

5.0 Test of Reasonableness

As a check of costs, HDR examined the per mile costs of other BRT and LRT systems. **Table 10** shows the total year of expenditure costs for comparable light rail projects now being funded or considered for funding by the Federal Transit Administration (excluding projects that are primarily tunnel) in Fiscal Year 2014. Year of expenditure costs for these projects range from \$63 million to more than \$204 million per mile. The LRT alternatives under consideration in the VBTES would cost \$84.5 million per mile (Alternative 2), \$99.6 million per mile (Alternative 1B), \$97.3 million per mile (Alternative 3), and \$108.7 million per mile (Alternative 1A). These costs are within the range of the other recent LRT projects.

Table 11 shows the per mile total development costs for some similar BRT systems in the United States, Canada, and Australia as shown in the Transit Cooperative Research Project's Bus Rapid Transit Practitioner's Guide (TCRP Report 118), as well as BRT projects being funded or under consideration by the Federal Transit Administration in Fiscal Year 2014. There are a wide range of costs from \$1.2 million per mile to \$60.9 million per mile, not accounting for inflation. The BRT Alternatives considered under the VBTES range from \$61.6 million per mile (Alternative 2) to \$105.7 million per mile (Alternative 1A). In between are Alternative 1B, at \$87.7 million per mile, and Alternative 3, at a cost of \$65.7 million per mile. If inflation is considered, the costs of the VBTES alternatives would be at the high end of the range of comparable BRT projects.

Table 10 | Capital Costs for LRT Projects Requesting Section 5309 Funding, FY2014

LRT Project	Total Capital Cost (YOE millions)	Length (Miles)	Cost (millions/mile)
Sacramento South Corridor Phase 2	\$270	4.3	\$63
St. Paul-Minneapolis, Central Corridor LRT	\$957	9.8	\$98
Charlotte, Northeast Corridor Blue Line Ext.	\$1,160	9.8	\$118
Portland, Portland-Milwaukie Light Rail	\$1,490	7.3	\$204
Dallas, Northwest/Southeast LRT MOS	\$1,406	21.0	\$67
Houston, North Corridor LRT	\$756	5.2	\$145
Houston, Southeast Corridor LRT	\$823	6.5	\$127
Houston, University Corridor	\$1,563	11.36	\$138

Source: FTA FY2014 Annual Report on Funding Recommendation

Table 11 | Recent BRT Project Costs

BRT Type and System	Year Opened	Miles	Cost (millions/mile)
Grade-Separated Busways			
Adelaide, Australia (guided bus)	1989	7.5	\$ 9.1
Brisbane, Australia	2001	10.3	\$ 32.0
Ottawa	1983	16.0	\$ 18.6
Pittsburgh: South Busway	1977	4.3	\$ 6.3
Pittsburgh: East Busway	1983	6.8	\$ 19.1
Pittsburgh: East Busway Extension	2003	2.3	\$ 29.9
Pittsburgh: West Busway	2000	7.5	\$ 50.0
New Britain-Hartford Busway (CT)	2015 (est.)	9.4	\$ 60.9 (YOE)
At-Grade Busways (Off-Street)			
Hartford: New Britain (proposed)	2007	9.6	\$ 15.1
South Miami-Dade	1996	8.2	\$ 7.2
South Miami-Dade Extension	2007	11.5	\$ 1.2
Michigan-Grand River BRT (Lansing)	2016 (est.)	8.5	\$ 25.3 (YOE)
Grand Rapids: Silver Line BRT (MI)	2014 (est.)	9.6	\$ 4.2 (YOE)

Sources: TCRP Report 118; FTA FY2014 Annual Report on Funding Recommendations

APPENDIX H-1:

FTA Standard Cost Category Worksheets

APPENDIX H-2:

Cost Estimate Backup Details

Draft Conceptual Cost
Estimates for Build Alternatives